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ABSTRACT

The Zimbabwe Secondary School Science Project (ZIM-SCI) developed student study guides, corresponding teaching guides, and science kits for a low-cost science course which could be taught during the first 2 years of secondary school without the aid of qualified teachers and conventional laboratories. This teaching guide, designed to be read in conjunction with the related student guide, includes instructional strategies, lists of required materials, laboratory procedures, and other information for a two-part unit in which students investigate: (1) the role of food as a fuel; (2) three major food groups (fats, carbohydrates, and proteins); (3) the use of food as a fuel in living things; (4) characteristics and reactions of carbohydrates; (5) digestion; (6) breathing; and (7) photosynthesis. A discussion of how concepts are developed in the unit is provided. Each section in this guide corresponds to a given section in the student study guide. (JN)

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ZIMBABWE SECONDARY SCHOOL SCIENCE PROJECT

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YEAR 2

TEACHER'S GUIDE UNIT G1

Energy for Living

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September, 1982.

The following symbols which appear only in the Teacher's Guide are used to indicate important points for you the teacher.

Take note of an important point.

This symbol indicates a preparation of apparatus which should be done well ahead of time. Please read these notes carefully and carry out the instructions well in advance.

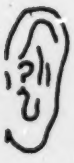
We have placed this symbol next to experiments where we feel there may be a possible danger. Please read the section carefully so that you know about the particular danger in that experiment. It would also be wise to refresh your memory on the appropriate safety or first-aid procedures described in the Zim-Sci Handbook.

This symbol appears next to activities which are not experiments but involve pupils in observation and perhaps collecting information. An example is the field trip.

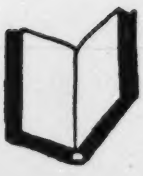
The following symbols will be used to indicate the points in the lesson at which teacher activity is particularly important. These symbols also appear at the corresponding points in the pupil study guides.

Practical work. The necessary instructions for each experiment will be given to you when you see this symbol.

Written exercises for the pupils. If possible these should be put on the blackboard before practical work begins so that the pupils can see what to look for.



Teacher information. The pupils will need extra guidance at these points. The information they will need from you is given where you see this symbol.



This symbol appears at a point where it is necessary for pupils to think over what they have done in the past few lessons. Set aside a period for this review activity. Encourage the pupils to read over their notes and the study guide section which they have just covered. It may be helpful to ask them to write a summary too.

AIMS OF THIS UNIT

At the end of this Unit the pupils should be able to:

1. State the names of the gases exchanged with the environment as a result of respiration and photosynthesis.

2. Identify oxygen, carbon dioxide, simple sugar and starch by simple practical tests.

3. Describe and explain digestion in simple terms.

4. Demonstrate and explain the release of energy from food by living organisms and by combustion.

5. Describe and give examples of the circulation of carbon, carbon dioxide and oxygen in nature.

ENERGY FOR LIVING

CONCEPT DEVELOPMENT SCHEME

A. Food as a fuel

To do work, machines need energy which they convert from the stored form. To work and live we need energy. In what way do we and other living organisms get it? There is energy in food. It is in a stored form as shown by burning foods to heat and light forms of energy. The food we eat is probably our fuel.

B. What sorts of food do we eat?

The three groups: Fats, Carbohydrates and Proteins - of which we eat carbohydrates in greater proportion. Carbohydrates are compounds containing Carbon Hydrogen and Oxygen. Carbohydrates can be shown to be compounds by breaking down to carbon dioxide and water with the release of energy and using up oxygen.

C. Using the fuel in living organisms

Living things give off carbon dioxide and heat and use oxygen indicating a reaction similar to burning within them.
(The experiments show that organisms use
oxygen and give off carbon dioxide & heat)
Energy can be changed from stored into several different forms.
In organisms the food fuel is used slowly as working energy
not as all heat and light
However, some heat is always given off during respiration.

Respiration is the reaction whereby, with the addition of oxygen to food, energy is released and waste water and carbon dioxide given off.

D. The carbohydrates

Within the carbohydrate group, there were many different foods - are they all only Carbon, Hydrogen and Oxygen compounds?
The differences between glucose, sucrose and starch and cellulose can be shown in tests (solubility, taste, iodine, clinistik, etc.).
They are all carbohydrates, but with different sized molecules.

E. Digestion

Glucose can be shown in a simple separation model to have much smaller molecules than starch.
Starch molecules, being large, cannot pass through the wall of the gut, or into a cell through the membrane.
Starch can be broken down in a chemical reaction to sugar.
Living organisms can break down starch molecules to glucose through the use of enzymes. (Demonstrated by saliva in digestion of starch.)
Plants and animals have enzymes which are able to build up or pull apart carbohydrate molecules.
Digestion is found to be the breakdown of large insoluble molecules into small ones which can pass into a cell. This function is performed by enzymes.

F. Breathing

As well as food, the cells of a living organism need oxygen.
How does a large organism get enough into the whole body?
A large surface area has been developed for diffusion such as in our lungs and the gills of water animals.
Breathing is shown to be a physical process to get enough oxygen into the body.

G. Photosynthesis

Children are usually aware that plants need soil and water to grow. They now know that carbohydrates contain carbon, which is not in water - so the source of carbon is found to be carbon dioxide in the air. The combining of the water and carbon dioxide is a chemical reaction needing energy and the source of energy is shown to be sunlight.
Oxygen is found to be a waste or by product.
A variegated (green and white)' leaf is used to show the need for the special green pigment chlorophyll.
The structure of the leaf is studied to find out how a leaf absorbs enough carbon dioxide from the traces in the air, and compared to the lung. Both leaves and lungs are found to have large surface areas.
Pupils should discover that a balance exists in nature, and that carbon dioxide and oxygen are cycled through respiration and photosynthesis. The energy from the sun is the energy used by all living things.

Bean plants which will be needed in Part II:

At the start of this Unit you should:

Take 40 beans and soak overnight.

P

Ask pupils to bring an old tin or plastic bag full of soil. Give them each a bean seed to plant. You can find a safe place to keep them. Once they germinate they should get some sunlight each day. They will take 4 - 6 weeks (depending on the weather), to produce the second leaves required for experimentation. The first 2 seed leaves may be used, but are rather too big for the small bottles. The next leaves produced have 3 smaller leaflets which are the ideal size.
Also note page 42.
Check that you have a variegated geranium plant growing well. (Page 37)

Experiment 1: Page 6 To see if many kinds of foods burn

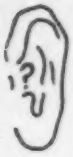
P

You will have to provide some of the materials for this experiment yourself. However, as each pair of pupils will only receive a sample of 1 kind of foodstuff, very small quantities are needed, e.g. about 5 peanuts; ½ slice of bread; 2 ml measure of cooking oil (or oil from peanut butter (dovi) and some sugar and mealie meal.

Quantities to give out:

5 drops oil per pair to 4 pairs of pupils
5 ml measure sugar per pair to 4 pairs of pupils
5 ml measure mealie meal per pair to 4 pairs of pupils
1 peanut or
1 cm cubed piece dry bread per pair to 4 pairs of pupils

Conclusion to Experiment 1:
The pupils should be able to see that the foods burn giving heat and light energy, as when they burnt maize meal in Unit B.

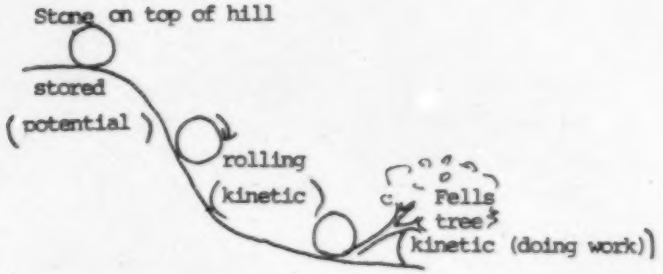


Page 8: energy conversion

Here you could revise some energy conversion chains from Unit B or discuss the ones listed below, arriving at the idea that the stored potential energy in fuels such as petrol, coal, wood or food can be changed to heat and kinetic (moving energy able to do work)

Some energy conversion chains:

1. Stone on top of hill



2. Candle → light and heat → spiral moving (kinetic)

(stored potential)

3. petrol → car moving

(stored potential) (kinetic)

4. Wood → fire → water boiling to steam → pot lid being moved up and down

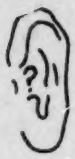
(stored potential) (heat and light) (kinetic)

5. Train

coal → boiling water → wheels moving

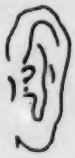
(stored potential) heat (steam under pressure) (kinetic)

Page 8: Do we need energy all the time? Say to the pupils:-



"Are you all quite still? Do you think you are still using energy? You are not running or playing or working, but you are still using energy. Your cells are growing and dividing, especially those of the skin, muscles and bone. Think of all the work your body is using. What is it doing while you are resting like this?

Firstly, you are breathing, your lungs are moving air in and out of your body.
Secondly, your heart is beating, pumping blood.
Thirdly, you are listening to me and thinking and your brain cells are working - at least I hope they are! Even when at rest, your body is working - all these kinds of work we call "life processes"



Who needs the most food? Page 9

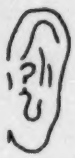
Our bodies all need a certain amount of energy to carry out the life process, but more is needed when physical work is being done, than when mental work is being done.

Therefore here are a few examples:

People with high energy needs are:	Bricklayer Farmer Gardener Tree feller etc.
People with lower energy needs are:	Office worker Shop assistant Tailor Driver etc.

Activity 1: Page 9:

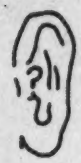
Here is a list of common foods to put on the board. For your information, a symbol C for carbohydrate, F for fat and P for protein has included to indicate the group to which the food belongs (Vegetables and fruit while containing a little carbohydrate, are mainly beneficial for the small quantities of vitamins and minerals).



Sweet potatoes	C
Sadza (isitshwala)	C
Sugar is	C
Tea or cool drink	
Sweets	C
Bread	C
Jam	C
Mahewu	C
Margarine	F
Peanut butter (dovi)	F
Meat	P
Chicken	P
Milk (some	P)
egg	P

After each pupil has come up and put a tick next to each type of food he or she ate yesterday, the ticks can be counted up. It will be found that the largest number of ticks are next to carbohydrates.

You can ask the class
"Which food did the class eat most of yesterday?"
They should answer "Carbohydrates."



Food groups - Page 10

It may be pointed out that certain foods contain fat and protein - such as milk and eggs. Beans have a lot of protein as well as carbohydrate and thus have been placed in both groups.

Discuss with the pupils what foods would form a balanced meal:

e.g: sadza and meat cooked in oil;
bread, peanut butter and chicken;
fish, potatoes and margarine

One type of food from each group has been chosen. You may also tell the pupils that vegetables and fruit are very healthy.

Experiment 2: Page 11 What happens when a carbohydrate burns

Make up the bicarbonate indicator class solution as in Unit F2. (15 ml stock indicator + 40 ml water). If it is not purple, add a few crystals of sodium bicarbonate until it has just turned purple. Give each pair of pupils about 2 ml indicator in their lids.

You will have to provide the sugar for this experiment yourself.

A film of water should appear on the lid. The bicarbonate indicator should turn yellow, showing carbon dioxide being given off.

Exercise 1: Page 13

1. When I held the shiny lid over the hot sugar, some ..... appeared on the surface.
2. When I covered the burning sugar with the boiling tin, the flame went out. This was because the ..... in the tin was quickly used up in burning.

3. The gas given off by the burning sugar into the boiling tin turned the purple bicarbonate indicator ..... This showed me that it was ..... gas.

4. When sugar burns it uses up ....., releases energy and gives off ..... and ..... in the chemical reaction.

Answers to Exercise 1

1: Water/moisture
2: oxygen
3: yellow, carbon dioxide
4: oxygen, carbon dioxide and water

Experiment 3: Page 14

To see if you give off carbon dioxide and water

Make up 100 ml class bicarbonate indicator solution (10 ml stock to 90 ml water). Give each pair of pupils:

5 ml bicarbonate indicator (class solution) in their bottles. The indicator should be purple.

1 straw

The indicator should turn yellow as the pupils breathe air containing carbon dioxide into it.

Exercise 2: Page 15

1. The indicator was ..... at the start of the experiment. This was because there was no ..... in it. After I blew into the indicator it turned ..... This told me that my breath had ..... in it. People give off ..... in their breath.

2. When I breathed onto the lid, ... appeared on the shiny surface. I give off ..... in my breath. I also give off water in my ..... and .....

Answers to Exercise 2

(a) Purple, carbon dioxide, yellow, carbon dioxide, carbon dioxide.

(b) Water, water, urine, sweat.

Experiment 4: Page 15:

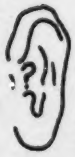
To see if we use up oxygen in the air.

You will need:

2 insect bottles and lids (large plastic bottle)
a piece of tubing
2 small pieces of candle
the Zim-Sci clock

Turn the two insect bottles upside down on your table. Have two small candles fixed to the lids next to the bottles as in the diagrams. Push one end of the tubing up into one bottle see diagram in pupils'guide

First get a pupil to breathe into the large plastic bottle through the tube then draw the air out of the bottle into his or her lungs. The pupil then breathes out a second time into the bottle and draws the air into his or her lungs again. Finally, breathe it back into the bottle for a third time. Pull the tube out carefully so that the bottle containing breath and the bottle containing fresh air are both resting level on the table. Tell the pupils that bottle 1 contains ordinary air, bottle 2 contains used air which has been breathed three times.



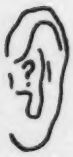
Light the two candles. Cover the first with bottle No. 1 Ask the pupils to time in seconds for how long the candle burns in ordinary air. Write it up on the board. Do the same with bottle No. 2. The flame will go out very quickly. Ask the pupils what this means to them. They should come to the conclusion that the second bottle with the breathed air contains less oxygen because it has been used up by the pupil.

Exercise 3: (Page 16)

1. The candle in bottle No. 1 burned for ..... seconds in ordinary air.
2. The candle burned for ..... seconds in air which the pupil had breathed.
3. This tells me that the air which the pupil had breathed had ..... oxygen than ordinary air.
4. The pupil ..... oxygen when be breathed.
5. Write a description of the experiment in your note books.
6. What is the source of a person's energy?
   Write an answer to this question based on what you observed in Experiments 2, 3 and 4.

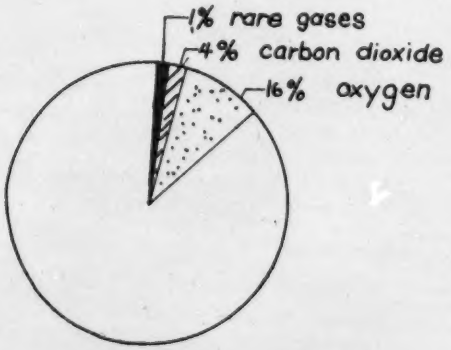
Answers: 3: less 4. used up.

6. The source of a person's energy is food.



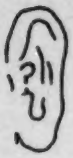
Tell the pupils:

A person does not use up all the oxygen from the air taken into the lungs at each breath. The composition of exhaled air - which has been breathed in and out once - is shown in this pie chart which should be put on the board for the pupils to copy down.



The composition of exhaled air.

Page 17: To see if pupils give off heat when they respire



You will need :

alcohol thermometer and clinical thermometer
burner
burner stand
boiling tin of water

Take the temperature of one pupil. Heat the water to the same temperature. Remove the burner, allow the water to stand. Ask pupils to feel the tin and their own foreheads. Point out that the warmth they feel shows that both are losing heat energy to the surrounding. At the end of the lesson take the pupils temperature again and the water temperature and compare them. Discuss the differences with the class. The result will show that the water has cooled down, but the pupil's body is keeping warm because the heat energy is being replaced.

While you are waiting for the water to cool, the pupils can start Experiment 5.

Experiment 5: Page 18 To see if germinating beans respire

You will need to soak about a third of a packet of beans overnight. They will swell and increase in size. Keep the rest of the packet dry. If your beans are old and damaged by insects you will need to buy new ones - any type of beans or peas will do. Bring a sheet of old paper to wrap around the beakers.

There will not be enough beans or thermometers for pupils in pairs, so it is suggested you divide the class into four groups.

Prepare 20 ml purple bicarbonate indicator
(18 ml water + 2 ml indicator)
4 squares of aluminium foil about 12 x 12 cms^2
4 x 1 metre lengths of thread
Pieces of paper for labels
Old paper to wrap around the beakers
Give out beans, indicator, etc. as in pupils' guide

The indicator should turn yellow, and the temperature should rise about 2°C. The pupils should look at the thermometers each day. In the control experiment - the dry beans which will not grow - no change in temperature or bicarbonate indicator should occur.

The pupils should realise that the soaked beans are growing. In order to get the energy to grow they are respiring fast, using up their food reserve.

Exercise 4: Page 19

1: When seeds germinate they get energy to grow from .....
2: Some of this energy is also released as .....
3: Seeds also give off ..... gas
4: My conclusions from these observations is .....

Describe, with the aid of a diagram, how you set up this experiment.

Answers:

1: Their food reserve
2: Heat
3: Carbon dioxide
4: Beans respire using their food store to get the energy to grow. I could tell that that they were respiring because heat and carbon dioxide were given off.

Experiment 6: Page 22 Investigating different carbohydrates

You will need to obtain some ordinary sugar.
The starch and glucose are in your supply.
For cellulose use small pieces of torn up clean paper, or dry grass or leaves broken up finely.

The glucose should dissolve quickly, the sucrose more slowly. Remind pupils that if they can "see through" the liquid, the substance has dissolved. Starch and cellulose do not dissolve. A clinistick turns purple in glucose only, remaining pink in the other substances. Iodine only turns starch a blue black colour, remaining yellowish when added to cellulose, sugar and glucose.

Exercise 5: Page 22 Give the pupils this table blank to copy into their books.

Characteristic	Cellulose	Starch	Sugar	Glucose
dissolves in water	(No)	(No)	(Yes)	(Yes)
clinistick turns purple	(No)	(No)	(No)	(Yes)
turns blue black with iodine	(No)	(Yes)	(No)	(No)

The 'yes' and 'no' answers have been filled in for your convenience in marking.

Exercise 6: Page 25

1. A test for starch is .....
2. A test for glucose is .....
3. ..... and ..... are soluble in water
4. ..... and ..... are not soluble in water

Answers to Exercise 6:

1. It turns blue/black in the presence of iodine.

2. It turns a clinistik from pink to purple.

3. Glucose and sucrose.

4. Starch and cellulose.

Pupil devised experiment: Page 25

Which of the foods we eat contain starch?

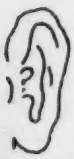
Have ready some different foodstuffs.
Here are some suggestions:-

Some small pieces of bread (starch present)
Some sugar or jam (no starch)
Some mealie meal or sadza (starch)

Some pieces of vegetable or fruit (starch not likely)
Some beans which have been soaked in water for 2 days (Starch present except where embryo shoot is growing)
Some grains of rice (starch)
Some pieces of potato/sweet potato (starch)
A piece of meat (no starch)
A piece of fat (no starch)
A few drops of oil (no starch)
Some egg white in the shell (no starch)

The pupils will need.

iodine solution
white lids
dropper (straws will do)
small plastic bottles
water
give each pupil pair <u>one</u> sample of one of the foodstuffs.



The pupils should realise that iodine solution is the test for starch. They should use droppers and white lids for the test. They may wish to use the small plastic bottles and shake the sample to see if it dissolves. If they ask for clinisticks, do not give them to the pupils. Say instead: "Is a clinistick a test for starch?" "What is it a test for?"

It is not a test for starch; it is a test for a simple sugar such as glucose.

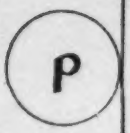
<u>Exercise 7: Page 25</u>

1: The sample of food I tested was .....
2: I used ..... to test it for starch. It did/did not show that starch was present

<u>Answers:</u>

1: The name of the food tested
2: Iodine, as in your list

<u>(There is no Exercise 8).</u>



Experiment 7: Page 26 To see if starch can be changed to a simple sugar in a chemical reaction

Make up 60 ml dilute hydrochloric acid as follows:

Measure 50 ml water in the measuring cylinder
Transfer this to the glass conical flask. Measure 10ml concentrated hydrochloric acid in the measuring cylinder. Add the acid slowly to the water
It may become a little hot. Take care, as acids burn.

Make up the starch suspension as follows:
Weigh 10 g starch powder. Put this into the other conical flask. Add 200 ml water and shake.

Give each pupil 5 ml in their small plastic bottles, shaking frequently as starch tends to settle to the bottom.

Give the pupil pairs:

2 ml acid, a large spatula full of bicarbonate of soda, 5 ml starch liquid in their bottles, and a few drops on their white lids.

Half a piece of universal indicator paper
A clinistick. They may fetch a few drops of iodine

Pupils should start this experiment at the beginning of the lesson as the starch and acid solution needs to boil for at least 15 minutes.

The sodium bicarbonate must be added in small quantities as it fizzes up strongly and will bubble out of the bottle.

The pupils should dip the end of the clinistick in the neutralized starch acid solution, and then remove it quickly, as, if left in the bottle, the coloured strip may come off. The clinistick should change from pink to purple showing that glucose is now present.

Exercise 9

I proved that the solution I used was starch because it went ..... when I added iodine. There was no simple sugar present as the clinistick ..... After heating with ..... and neutralizing with ..... the starch solution now contained ..... This was shown when the clinistick turned .....

Conclusion: Write your own conclusion to this experiment

Answers to Exercise 9

Blue-black
did not change colour
acid
Bicarbonate of soda
Glucose /simple sugar
purple

Conclusion

Starch can be broken into small molecules of sugar by a chemical reaction.

Experiment 8: Page 29 To see if saliva changes starch

P

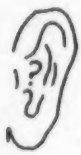
Start this experiment at the beginning of a lesson.

Make up some more starch suspension as follows:
Mix two 5 ml measures of starch and 200 ml water in a conical flask.

Give each pupil pair 2 ml starch liquid in one of their small bottles, a clinistick, a thermometer and some thread. Have iodine solution on your desk in dropper. Pupils should leave the clinistick in the bottle for about a minute when testing for glucose both times.

N.B: The pupils may remove the caps from their bottles after shaking and replace them after testing with a clinistick at first. If the bottles are capped they can float in the warm water and do not need to be held in place with pegs. (There may not be enough pegs to use

two per pair of pupils). The clinistick will remain pink after first testing the starch, then turn purple in the solution after the saliva has acted on the starch for about 20 minutes, showing that the saliva has changed some starch to glucose.



Page 30:

An enzyme normally does its work in a living organism. Saliva is made in our bodies to work in our bodies. It is most comfortable and so works best at the same temperature as our bodies.

Exercise 10: Page 31

Table of readings.

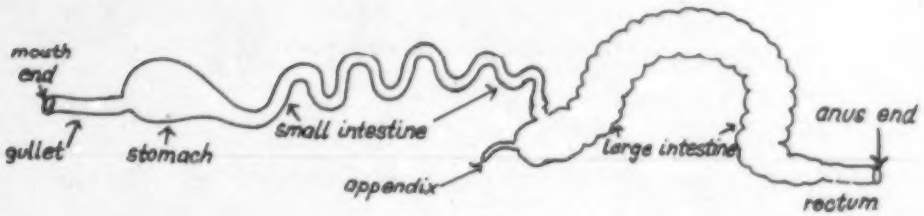
	Colour of clinistik at start	Colour of clinistik after 20 minutes	Deduction
Bottle 1 with starch and saliva	(pink)	(purple)	(glucose present)
Bottle 2 control contains starch but no saliva	(pink)	(pink)	(no glucose present)

Put this on the board blank for pupils to fill in. The expected answers are filled in in brackets for your easy marking.

Exercise 10 Conclusion: .....

Conclusion: The saliva in our mouths can change/break down starch molecules into simple sugars/glucose molecules.

Put this diagram of an unwound and stretched out gut on the board for the pupils to copy down in their books.

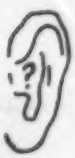


Activity 2: Page 33:

Give each pair one small spatula of starch and one small spatula of glucose in their small beaker .

Also one piece of filter paper, a clinistik etc. as in the pupil's guide.

Cut one piece of filter paper into 20 thin strips. The pupils can place 1 or 2 drops of iodine on the end of a strip and use it to test for starch.



Discussion on gut model:

The only way food can get into the body is through the wall of the gut. The gut is made of cells packed together to form a tissue.

You know that water and dissolved substances can pass into a cell through the small holes in the wall. Water can pass through a filter paper through the small holes. Substances dissolved in water can also pass through.

Substances which do not dissolve in water cannot get into a cell as their molecules are too big. Therefore, they cannot diffuse through the cells of the gut wall into the body.

In this model of the gut you see that water is passing through. But what do you think is in the water?

You find that glucose has molecules small enough to pass through and bring energy to the tissues, but starch has not. This is why starch molecules need to be broken down into soluble sugars by digestion.

Activity 3A page 35

In the pupils' guide there are 2 activity 3's, so we have called this one 3A and the next one 3B.

Give out bioviewers and biosets ZS/3. Pupils should make a quick diagram of the salivary glands and label the large mucus cells and pink enzyme producing cells on slide 4.

They should then make a quick diagram of the lining of the intestine labelling the villi and blood vessels.

They should then copy the cross-section of the intestine diagram.

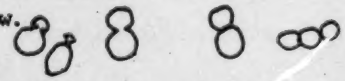
Experiment 9: Page 36:

Does yeast use glucose to respire?

To demonstrate yeast cells under the microscope.

Before the lesson, warm up some water to body temperature (about 37°C). Half fill a plastic cup with this warm water and add 2 spatulas glucose and 1 spatula yeast. During the lesson put a drop or two of this liquid on a slide and cover with a coverslide A drop of methylene blue made up as in Unit E_1 will make the cells more clearly visible.

The pupils may come up to look at this and make a simple drawing while waiting for the bicarbonate indicator to turn purple. With luck they may see (under the high power of the microscope) some single cells dividing into 2 cells as they grow.



Give each pupil pair 2 spatulas glucose and 1 spatula yeast, a plastic bag and 2ml purple bicarbonate indicator. The yeast respires more quickly if placed in the sun. The bicarbonate indicator should turn yellow within the lesson period showing respiration is taking place.

Keep one sample from the pupils' experiment.

If you test it with a clinistik (after at least two days) the glucose should have been used up and the clinistik should remain pink.

Exercise 11: Page 37

At the beginning of this experiment the beaker contained some yeast and 2 spatulas of ..... in water. I saw one called yeast organism under the microscope and some were growing. They were getting their energy by ..... I could tell this because they gave off ..... which turned bicarbonate indicator ..... After 2 days a clinistick dipped in the liquid remained ..... This showed me that all the ..... had been ..... Yeast cells seem to have an .... which breaks down ..... to ..... and water.

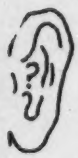
Answers to Exercise 11

glucose, respiring, carbon dioxide, yellow, pink, glucose, used up, enzyme, glucose, carbon dioxide.

Activity 38 Page 38

You will need the sponges from the materials kits. Have a few sheets of paper ready for some pupils to crumple up. Point out that the water, when inside the sponge, is in contact with a large area of sponge surface, so the amount of surface area is large in proportion to the volume.

Page 40: Making a model of an air sac



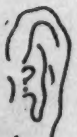
Blow up and tie the neck of a round balloon.
Ask a pupil to come up in front of the class.
The pupil should hold two hands around the balloon.
The fingers should be touching at the tips, but spread apart, as in the diagram.

Explain the model to the pupils in this way:

We will imagine the balloon is an air sac (point to the balloon). It has a thin wall.
Imagine the arms are blood vessels. The right arm is bringing blood from the body (point to the right arm).
This blood has a lot of carbon dioxide in it and little oxygen The fingers (point to them) represent very thin walled blood vessels, and the carbon dioxide is passing out of them into the air in the balloon, or air sac. At the same time oxygen is passing from the air sac into the small blood vessels. If we imagine the fingers are joined at the tip, you can see that the small blood vessels join up (point to the left hand) and the blood returns to the heart - up the blood vessel represented by the left arm."

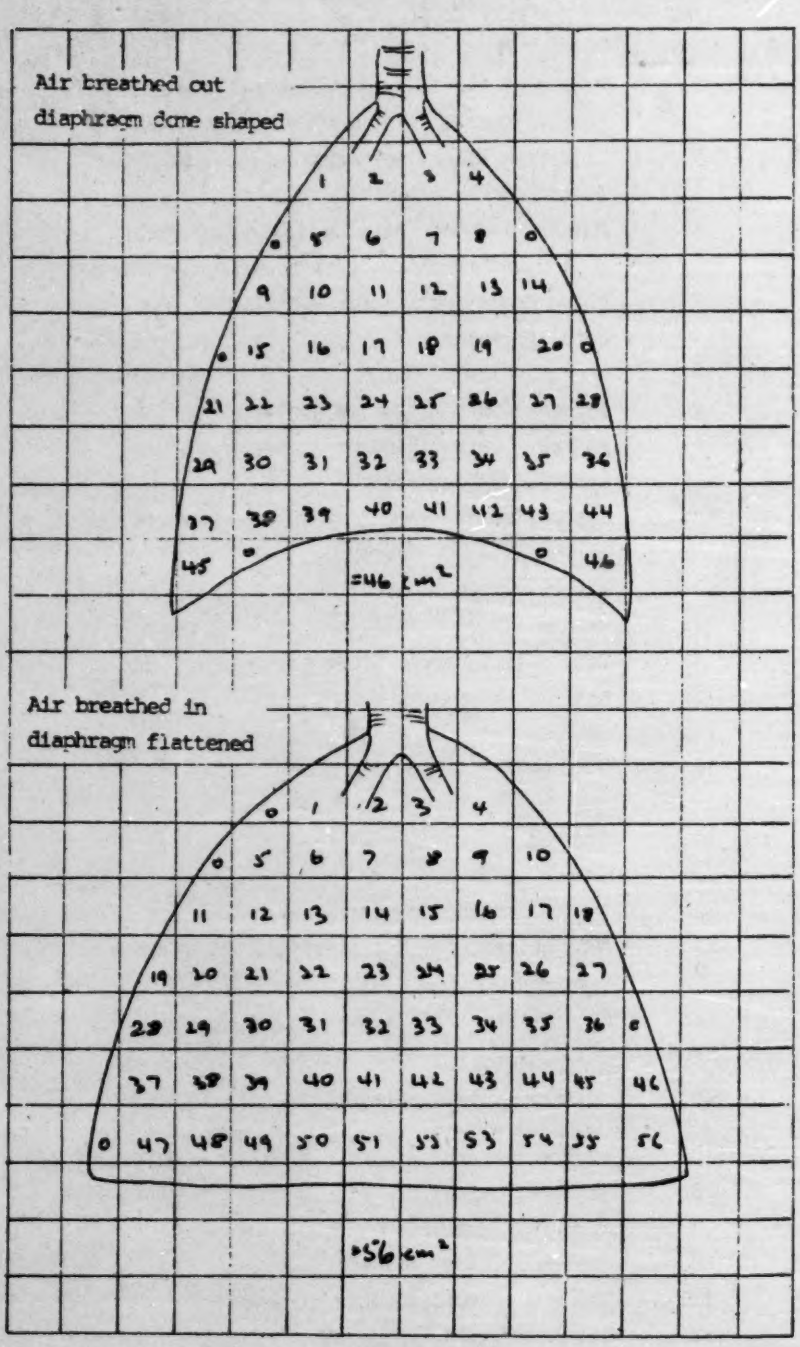
Page 43: Activity 4: How do your lungs work

Although it is the volume of the space occupied by the lung that actually causes the pressure change, the exercise of counting squares is done on area. It should, however, convey the idea of change. The numbers of the squares are filled in for you. The spaces occupied by the trachea have not been counted.



Tell the pupils:

"When the space inside the chest is increased, the particles of air inside are spread out more, and they do not bang about as much. Thus the pressure decreases. So air rushes into the lungs from outside the body, where the pressure is higher. Then when the rib cage presses in and the diaphragm pushes up, the space in the chest is made smaller. Now there are a large number of air particles inside the lungs, which exert a greater pressure. These particles move out of the lungs so that the pressure inside equals the outside pressure again.


Air breathed out
diaphragm dome shaped
1 2 3 4
0 5 6 7 8 0
9 10 11 12 13 14
0 15 16 17 18 19 20 0
21 22 23 24 25 26 27 28
29 30 31 32 33 34 35 36
37 38 39 40 41 42 43 44
45 0 0 46
=46 cm²
Air breathed in
diaphragm flattened
0 1 2 3 4
0 5 6 7 8 9 10
11 12 13 14 15 16 17 18
19 20 21 22 23 24 25 26 27
28 29 30 31 32 33 34 35 36 0
37 38 39 40 41 42 43 44 45 46
0 47 48 49 50 51 52 53 54 55 56
=56 cm²

Answers to How Much do you Know?

Part 1

1. Fuel food 2. Stored/potential/chemical
3. Heat, light 4. Heat, moving/kinetic/work
5. Breathing digesting heart pumping, thinking sweating
6. Farmer, (anyone doing hard physical work) Typist, storekeeper, office worker (anyone doing mental work - perhaps sitting down)
7. Fats, proteins
8. Energy
9. Carbon, hydrogen and oxygen.
10. Energy. Carbon dioxide, water
11. carbon dioxide, yellow
12. Carbohydrate + oxygen ⟶ energy + carbon dioxide + water.
13. Water, carbon dioxide.
14. Oxygen
15. Heat energy, carbon dioxide
16. food cells respiration
17. Glucose, sucrose, starch, cellulose
18. Glucose, cellulose, sucrose
19. Starch
20. Glucose
21. Enzyme
22. Saliva starch sugar/glucose
23. Anus, gullet, stomach, intestine, intestine rectum.
24. In solution diffusion
25. villi
26. Glucose, carbon dioxide, energy
27. digested food, oxygen, lungs, cells carbon dioxide misprint "causes" should be "carries"
28. physical
29. chemical
30. carbon dioxide, oxygen
31. Trachea bronchi alveoli/airsacs
32. Rib bones/ribs, diaphragm
33. carbon dioxide oxygen

water vapour may be given but is not the required answer

N.B.

PART II

Please read this section through completely now.

Some suggestions have been given on planning the experiments to save time and give good results. Please try to follow them where possible. Remember plants are living things i.e. They need time to settle in the light before they start to photosynthesise. Leaves which have been in the dark too long or have got too hot do not give good results as they are half dead. Leaves which are not in the dark long enough still show starch

N. B.

There are 2 exercise 15's, so in your guide they have been called 15A and 15B.

Exercise 12: (Von Helmont's experiment) Page 49

1: Why did Von Helmont weigh the soil dry and not wet?
2: Why did he fit a lid on the pot?
3: Why did the lid have small holes?
4: Where do you think the mass of the tree came from?

Answers

1. He weighed the soil dry as, if it had some water in it, he would not know the exact amount of the soil only, at the beginning and end of the experiment.
2. He fitted a lid on the pot to prevent soil being blown out of the pot.
3. The lid had small holes to allow water to get to the roots of the tree.
4. Some pupils may agree that the increased mass came from the water. Other pupils may realize from Experiment 6 that plants are made of cellulose, a carbohydrate containing carbon, hydrogen and oxygen, whereas water only contains hydrogen and oxygen. They may realize that, as there is air available to the plant, and it contains carbon dioxide, that this is where the carbon comes from. It is a difficult concept for a child to understand, however.

Experiment 10: Page 51.

Do plants take up carbon dioxide from the air?

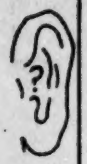
You will need:

The baby bath half filled with water
about 200 ml bicarbonate indicator solution
(20 ml stock bicarbonate solution and 190 ml water)
(If yellow add a few crystals of sodium bicarbonate until just purple.)

Give the pupil pairs 10 ml bicarbonate indicator.

The Experiment:

The pupils should choose soft fresh plants with small to medium sized leaves - no longer than the bottles - (not large leaves which have to be cut or torn.)
Place the bath out in the sunlight.
When the pupils cover the candle with the boiling tin it will go out.
It will have used up the oxygen in the tin and bottles, and will have given off carbon dioxide. This carbon dioxide will now be present in equal quantities in each bottle and will turn the indicator yellow. After 1 hour in the sunlight the control bottle should remain yellow, the indicator in the bottle with the plant material should turn purple. This shows that the plant has absorbed the carbon dioxide.
While the pupils are waiting for their plants to absorb the carbon dioxide, you can carry out the following question and answer discussion with them to ensure they understand all the steps in the experiment.



Question and answer session.

Q. Why did the candle go out under the tin?
A. Because all the oxygen was used up and it needed oxygen in order to burn.

Q. What colour did the indicator turn to?
A. Yellow.

Q. Why did the bicarbonate indicator turn yellow?
A. Carbon dioxide was given off by the candle when the oxygen was used up. This carbondioxide dissolved in the indicator solution turning it yellow.

Q. Was there the same amount of carbon dioxide in both bottles?
A. Yes

Q. Why do we use two bottles, one with a plant and one without?
A. So that we know that if any changes occur in the bottle with the plant, and no change occurs in the other bottle, it is the plant which is causing the changes. The other bottle is called the CONTROL.

Q. Why do we not want the bottles to get too hot?
A. Because the plants are living things. Air and wind cannot cool them in the bottles as they are capped. If they get too hot they will die - just as an animal would.

Q. How did the carbon dioxide get out of the bicarbonate indicator and into the plant?
A. By diffusion into the air, then into the cells of the plant

If no bottles have turned purple by the end of the lesson the light may not have been bright enough. Tell the pupils to come back later in the morning to look. The control bottles should be kept for Experiment 12 so as not to waste the bicarbonate indicator. Throw leaves away .

Exercise 13: page 52

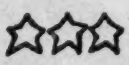
1. I took 2 bottles, containing the same amount of bicarbonate indicator, and placed both in the same tin with a burning candle so that both bottles would get the same amount of ..... One bottle was to test a leaf; the other was a .....
2. The indicator turned from ..... to ..... when the candle burned. This was because ..... diffused from the air into the indicator.
3. I placed a leaf in one bottle and put both bottles in the ..... After ..... the indicator in the bottle with the leaf turned ..... The indicator in the control bottle was .....
4. This told me that .....

Answers to Exercise 13:

1: Carbon dioxide, control.
2: Purple, yellow, carbon dioxide.
3: Sunlight (time taken), purple, unchanged.
4: The leaf took in carbon dioxide from the air in the bottle.

Put this conclusion on the board for the pupils to copy

Conclusion: The hypothesis is proved:



Plants do take carbon dioxide into their leaves which are held out into the air. This is the source of their carbon.

Experiment 11: Page 53.

To see if starch is present in a leaf.

Have ready:

A Mazoe bottle filled with methylated spirits
A funnel to help pour meths. into the small bottles
Iodine solution and droppers.
forceps

After the pupils have put their water on to boil they should fetch a small leaf about 3cm long from outside. Some pupils may use a piece of bean leaf, but a few different leaves from weeds outside would be a good idea.

The leaves must come from plants which have been in the sunlight. If the bean plants have been growing indoors, see that they are put outside in the sun the day before, and have sun the morning of the experiment.

Make sure that the pupils blow out their burners when the meths. is in the hot water.

The leaves should lose the green colour when heated in methylated spirits and become whitish. After adding iodine solution they should turn almost black, showing the presence of starch.

At the end of this lesson, give the pupils their bottles from Experiment 10 (containing bicarbonate indicator) and let them start Experiment 12, so that they can be ready for the following lesson.

Exercise 14 page 54

1: I took a leaf from a plant and put it in boiling water to .....
2: I then put it in hot meths. to .....
3: I dropped iodine solution over it and it turned a ..... colour.
4: This showed me that ..... is present in a leaf. The leaf may be a ....

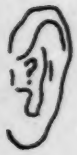
Answers to Exercise 14

1. Kill the leaves and break open the cells.
2. Remove the green colour.
3. Blue/black.
4. Starch, starch factory.

(Some leaves may contain sugar instead of starch, but this is rare; most pupils should find starch in their leaves. Do not tell them yet that sunlight is important).

Experiment 12: Page 55 Do plants take in carbon dioxide in the dark?

The bean plants grown by the pupils should be used for this experiment. Two leaves should be put in the control bottles saved from Experiment 10. Provide space in your cupboard, or a cardboard box which can be closed to exclude light, in which to keep the bottles with their leaves for 2 to 3 days. After 2 days the pupils may observe that the colour of the bicarbonate indicator has not changed from yellow to purple. Ask them to think what this means.



The pupils have deduced that no carbon dioxide has been taken in. Then, because the plant leaf has kept on living it will have used up its stored starch energy and there will be no starch left in it. Biologists call this a destarched leaf. The pupils can now test one of their leaves to confirm this conclusion. Tell them to use the same method as in Experiment 11. Have the necessary apparatus ready.

P

The other leaf in the bottle is a destarched leaf for use in Experiment 13. This leaf should be used the same day (by starting Experiment 13 at the end of this lesson) or the following day. If Experiment 12 is done on a Friday, and there is no time to start Experiment 13, get the pupils to put fresh leaves in the dark for use on Monday or Tuesday.

N.B.

If, for some reason, the class has no bean plants, you yourself will have to spend a few days trying out local leaves. Bean leaves were chosen for this experiment as they are soft, so the colour is easily removed. Some leaves do make sugar instead of starch.

P

Others do not "destarch" readily, so try out a number of different types of plants.

Destarch them in a cupboard, then follow out Experiment Experiment 13.

Exercise 15 A, Page 55

1. When I put the bottle containing my leaf in the cupboard, the indicator was .....

2. After 24 hours, the indicator was .....

3. This showed me that the leaf .....
.....

4. I took one leaf and tested it for starch and

I found ..... in the leaf

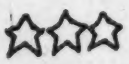
5. This showed me that ..... and .....

Write up the method you used to test the leaf for starch.

Answers

1. Yellow 2) Yellow 3) Did not take in carbon dioxide in the dark. 4) No starch/very little starch 5) The leaf did not take in carbon dioxide in the dark, and did not make starch in the dark.

Give this for the pupils to copy in their notebooks:



When a leaf has been in the dark for some time it has used up all its food and is called a DESTARCHED leaf.

N.B.

P

Experiment 13: Page 56 To see if starch is made in a destarched leaf where light falls on it

You would be advised to arrange this lesson with each class on separate days because the apparatus may be needed for a single class for the whole morning. If the school had many classes, each class could do the experiment in groups of 4, thus 2 classes could do it in one day.

You will need to have ready at the start of the lesson

a few pairs of forceps
20 pieces of aluminium foil about 7 cm x 7 cm
scissors
baby bath one-quarter full of cold water placed in bright sunlight. (If, however, the weather is very hot, put it in half shade such as under a tree).
iodine solution and dropper
the bottles containing the pupils' leaves from Experiment 12 which have been in the dark for 2 days.

At break, or lunch time, have ready:

a container of boiling water (large boiling tin)
a large sheet of paper in the cupboard - or a cardboard box.

The pupils' leaves should be dropped in your boiling water with the foil still in place. After a minute the leaves should be removed and left on the paper in your cupboard until the next lesson.

Tell the pupils,

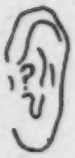
It is necessary to kill the leaves or they will use up the starch they have made or turn it to sugar during the night and the experiment will be spoilt.

The pupils can start the next lesson by:

1. Putting their water on to boil
2. Fetching their leaves and meths from you (they should be able to identify their own leaves from the way they placed their aluminium foil)
3. Continuing their experiment from the point where they place their leaves back in hot water and then into methylated spirits.

The part of the leaf which was covered by the foil should be yellowish, showing no starch was made, whereas the part of the leaf which was exposed to light should be blackish, showing that starch was made. If there is not much starch present, the pupils may detect it more readily if the lid with the leaf is held up to the light.

Discuss with the pupils the presence of a control in this experiment(13)



Ask the pupils: "Where is there a control in this experiment?"

The answer is:
The leaf has been destarched. It is exposed to the same conditions all over - that is it is kept cool by the water, and it is put outside. The one difference is that part of the leaf is given light, and the part which is covered by foil is not given light. As light is the condition being investigated, a control must be done where light is kept out.

Exercise 15 B: Page 57

1: I used a ..... leaf, and covered part of it with foil.
2: The part covered by foil was to keep ..... out and was the ..... for the experiment.
3: After being in the sunlight I removed the colour from the leaf and tested it with .....
4: Where the leaf had been covered, the colour was now .....

5: Where the light fell on the leaf the colour was .....

6: This told me that .....

Answers:

1:	Destarched	4:	White/pale yellow
2:	Light control	5:	Blue/black
3:	Iodine	6:	Starch was only made where the leaf was not covered and light fell on it.

Experiment 14: Teacher Demonstration Page 59

To find out if oxygen is given off when a plant is making food in sunlight.

Start this experiment at the beginning of a lesson.
You will need:

2 large plastic insect bottles
2 small candle stubs
some leafy plant material.

Take 2 large plastic bottles (insect cage ones). Stick a small candle stub inside the lid of each. Wedge some leafy weed or plant around the insides of one bottle, in such a way that it will not be burnt when a candle is lit, and the pupils can still see the candle.

See diagram in pupils' guide.

Light each candle and quickly invert the bottles over them. Let one pupil time the number of seconds before the flames go out. Give each bottle lid a twist to screw them on, then place them both outside in a bright place which is not too hot. If it is summer, put them under a tree or on the verandah.
Keep the bottles lid side down
Ask the pupils: "Why have the candles gone out in the bottles"? They should be able to answer "Because the candles have used up all the oxygen".

Firstly open the empty bottle just enough to relight the candle. Ask a pupil to time how long it burns this time. It will go out almost immediately. Then do the same with the bottle containing the plant. It should burn for a few seconds, much longer than the empty bottle. Ask a pupil to time it too.

Tell the pupils:
Both bottles were closed while outside. Then each was opened for a short while to light the candles and closed again. If the candle in the control bottle burns a short while, it will be using the little air that got in while the bottle was open. Did the candle in the bottle with the plant burn for longer? How much longer? (..... seconds). This shows that the bottle with the plant had more oxygen for the candle to burn in. Where do you think the oxygen came from?

The pupils should guess that the oxygen must have come from the plant.

Exercise 16: Page 60.

1: When the candles burned, they used up ..... in both bottles.
2: After being in the sunlight for a time the candle was relit in the bottle with the plant and burnt for .....
3: When the candle was relit in the bottle without the plant it burned .....
4: This showed me that the bottle with the plant contained more ..... than the control.
5: Therefore the ..... must have come from the plant.

Write an account of this experiment and your conclusion.

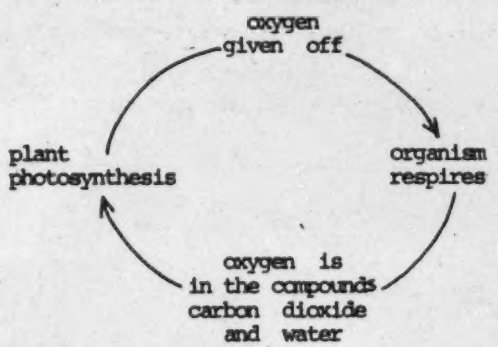
Answers to Exercise 16

1. Oxygen
2. (time taken)
3. (time taken)
4. Oxygen
5. Oxygen

Conclusion. Plants produce oxygen when they make food in the sunlight.

Exercise 17: Page 61

Here is a simple version of part of the oxygen cycle. You may need to help the pupils with this exercise.



A Variegated leaf Page 63

"If we are testing to see if the green colour is necessary in the making of carbohydrate, we need a leaf which has a green part and a part which is not green to act as a control. If we find starch in the green part, but not in the white part we will know that it is the green colour which is involved trapping light to make starch"

37

Experiment 15: Page 63 To see if the green colour is important in making starch

Have ready:

20 variegated leaves
iodine solution and droppers
forceps/tweezers
methylated spirits

You will have been supplied with a variegated geranium plant; hopefully, you have planted it in the garden or in a bigger container than that first supplied. See that it has plenty of light, particularly the day before and the day of the experiment.

If your plant has died, try to get some more variegated leaves from another school nearby, as this is an important experiment. A piece of the plant, planted in a tin of soil and watered, will grow.

When the leaf is removed from the hot meths, it will be white all over. When iodine is dropped on it, it will turn dark, where starch is present, only in the areas which were green before.

If you cannot get a plant, discuss the experiment with the pupils, and let them look at and read about slide 6 on Bioset ZS/2.

Exercise 18: Page 64

1. A variegated leaf is used to find out if the .... in a leaf is important in making starch.
2. The white part of the leaf is the ..... in the experiment
3. After removing the colour and testing with ....., the part of the leaf which was green before turned ..... and the part which was white before was .....
4. This showed us that .....

Answers:

1: Green colour.

2: Control.

3: Iodine, blue/black, still white/pale yellow

4: The green colour of the leaf is necessary for the plant to make starch/food.

Activity 5: Page 66

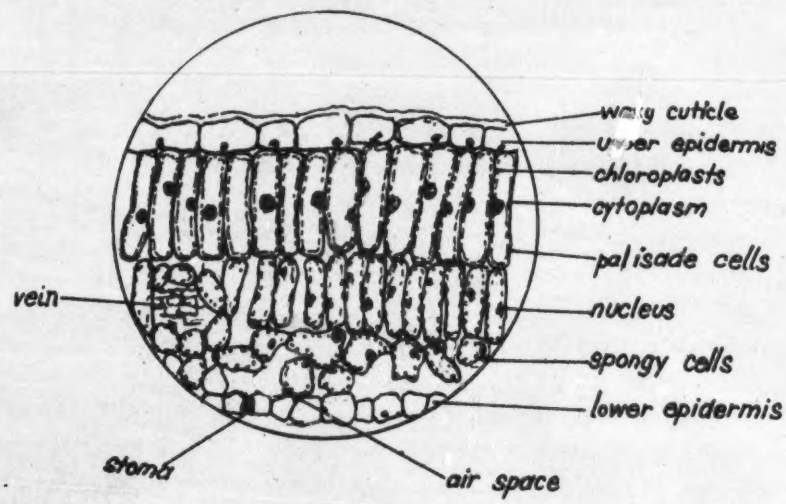
Looking at the factory inside a leaf

Give out bioviewers and Biosets ZS/2 (this is misprinted in the pupils'guide as Z5 2.)

P

Look at the slides and read the bioset before the lesson. (Answers to the questions have been provided for your ease in marking.)

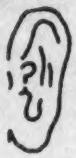
This diagram is of a section (slice) of a leaf. Put it on your board so that you can point to the different tissues as you tell the pupils about them. It will help them to identify the parts on their slides.



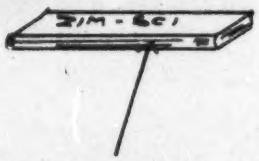
N.B.

Note please correct spelling of palisade in pupils' guide; also, chlorophyll in diagram.

Tell the pupils.



"You are going to look at some slides, the first 2 of which are thin slices of a leaf which show you the cells inside, as if you were looking at the end of your book."



(Show them the end of a book)

"Inside there are many cells, all having definite jobs to do. I will tell you about these now while you look at the diagram.

Like the cover of a book, there is an epidermis skin consisting of cubic cells. These are covered with a waxy cuticle which prevents water loss from the leaf. Underneath the epidermis there are long cells which, because of their shape, allow light in easily. These long cells are called palisade cells. They are the main photosynthesising cells, and their cytoplasm looks green. This is because of the green lumps called chloroplasts. Chloroplasts contain the chlorophyll which traps light.

The nuclei can also be seen.

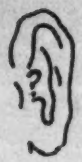
Below the palisade layers, are spongy cells. They are round and have spaces between them so that the air can pass between them and get to the pallisade cells.

The lower surface of the leaf also has an epidermis. This lower epidermis has holes in it called stomata. They can open and close, and are there to let the air in. The vein brings water to the cells.

Look at slides 1, 2 and 3 and read about them before answering the questions."

N.B.

The stoma on slide 1 is towards the left of the lower epidermis. The cuticle can be seen as a clear layer on top of the epidermis in slide 2. Cell 2 should read cell E and is an epidermis cell.



<u>To see stomata from a fresh leaf under the microscope.</u>
<u>Page 66.</u>

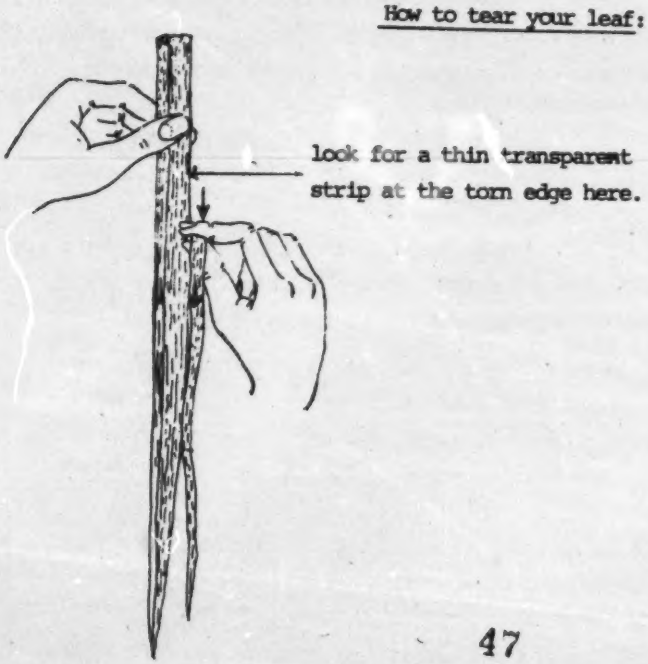
Obtain a thick fresh leaf, such as an onion, cabbage, rape or mealie leaf and keep in water until needed. Practice making a slide before the lesson.

Have ready:

- Microscope
- Slides and coverslides
- Iodine solution
- Mounted needle
- A piece of filter paper
- Water
- Dropper

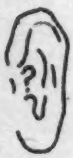
Follow the instructions and diagram. Your leaf must not be wilted! If there is time you could allow the pupils to make slides too, under your guidance.

<u>How to tear your leaf:</u>



To see stomata and epidermis cells under the microscope using onion, cabbage or mealie leaves, tear the leaf by holding in left hand and pulling the leaf towards you with the right hand. At the edge of the torn strip look for a tiny part where it is like tissue paper (it will look almost white) and you see light through it. Cut this piece of the leaf off and place on your slide. Add a drop of water, a drop of iodine, then the cover slide (Here the iodine is used as a stain not to show the presence of starch)

Place under the microscope, and move the slide until you are looking at the thin transparent edge. You will see one layer of epidermis cells, as in these diagrams with, here and there, the "lip"-like stomata.

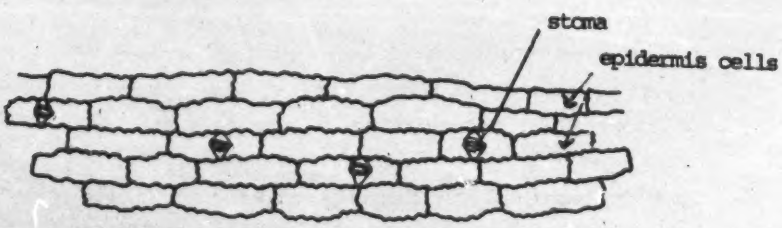


Show these to the pupils.

Here are some pictures to help you identify the cells and stomata of some leaves.

onion leaf

cabbage leaf



mealie leaf

Notes on the tissues in slides 1 and 2

1. Cuticle
   This is a waxy layer to prevent water being lost.

2. Epidermis
   A skin of protective cells on the upper and lower surfaces.

3. Palisade cells are long cells containing chloroplasts and are the main photosynthesising cells.

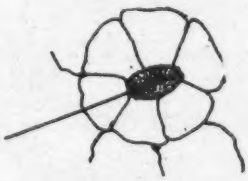
4. Spongy cells have air spaces to allow air to pass through them.

5. The vein brings water to the leaf cells and takes food away from the leaf to other parts of the plant.
6. Chloroplasts contain chlorophyll to trap light energy.

7. A stoma is a gap which can open or close to allow gases to be exchanged in and out of the leaf

Slide 3

The pupils should only draw one stoma



P

Root hair Page 66

A week before the pupils do exercise 19, you should prepare some bean seeds so that live root hairs can be seen.

Soak 4 beans overnight. Keep them damp between layers of paper. As the root grows, fine, fluffy cottonwool-like root hairs may be seen near the tip.

Pass the beans and hand lenses around for the pupils to see the root hairs(if the class has no hand lenses, use the removable lens from the bioviewers).

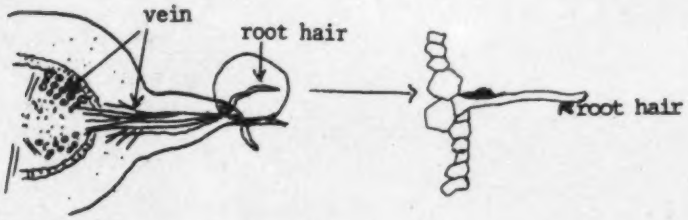
Ask the pupils: "Why should there be so many tiny root hairs? Can you see any similarity in purpose between root hairs and villi?"

Root hairs provide a large surface area to take in water. Villi provide a large surface area for taking in dissolved food.

Explaining the path of water Slides 4 & 5 ZS/2

Pupils should look at slide 5 first; then slide 4

The slide No.5 is a very difficult one for the pupils to understand.



what you see on slide 5 what you see on slide 4

You may have to put this diagram on the board for the pupils. Slide 4 is much more magnified than slide 5

The path the water takes from the root hair through the little (branch) root is quite clear, but the path up the big root is not so clear. The big root is at right angles to the branch root, so the tiny water tubes of the vein inside show up as circles - like looking end on at a straw. The water carrying tubes are numerous and grouped together in a ring near the centre of the root.

Explain it this way:
"Pretend your outstretched finger is a root hair. Your arm is the branch root. Your body is the main root up which water is to travel to your head. The slide would show a section cut through at your shoulders.

Exercise 19: Page 66

Describe the path water takes from the soil to the leaf.
Make diagrams of a root hair and the vein.

Answers:
The water in the soil passes through the wall of the root hair cell, then into the vein of a branch root. These branch veins join up to pipe-like large veins which continue up the stem of the plant to the leaves

These are the sort of drawings a pupil should make.

Vascular tissue

Exercise 20: Page 67

Write an account as in Experiment 15.
(This is a revision exercise)

Exercise 21

Answers to Bioset ZS/2 questions

Tell the pupils to write brief answers or they will take too long.

1: In the leaf, particularly in the chloroplasts.
2: The palisade tissue is on the upper surface of the leaf. The long shape means there are fewer cell walls, and so more light can get in.

3: Mostly in palisade tissue and sometimes in the spongy layer, but none in epidermis cells. They are round green lumps containing chlorophyll, which traps light. They can be seen in slides 1 and 2.

4: Stomata are holes in the leaf surface for air to pass in and out of the leaf. Yes, there are many on the plant, particularly on the underneath surface of leaves. There are more on the underside because the sun is not striking this surface, so less evaporation will take place as it is cooler. Stomata often close during the hot part of the day so as not to lose too much water. They can be seen on Slides 1 and 3.

5: Root hairs are important as they provide a large surface area for water to pass from the soil into the plant. They are found at the ends of the roots.

6: Veins carry water from the root hairs to the rest of the plant. The veins, shown on slide 5, are like long pipes, which are like small circles when cut across as if one were looking at the end of a straw.

7: A variegated leaf. The green part has chlorophyll to make starch. The white part does not contain chlorophyll and does not make starch, so acts as a control in the experiment to see if chlorophyll is necessary for making food.

8: Iodine. Blue/black. 6, 7 and 8.

9: By covering up part of a destarched leaf, putting it in the sunlight, and later testing to see where in the leaf starch had been made.

10: The sugar and starch formed in the leaves is either used by the plant to respire or stored in special places.

We cannot see the cell walls in slide 8 because they do not become stained with iodine.

Activity 6: Page 68

Divide the class into 2 or 4 groups. Allow 1 pupil from each group to fetch a small weed or branch possessing 20 or 30 leaves.

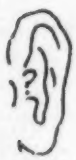
Ask the pupils for their guesses about the surface area of the weed or branch they have. Write each guess on the board under the appropriate group.

See that each pupil gets at least one leaf from the sample of plant material.

Remind the pupils that the squares should be counted as in the lung diagram according to whether the square is more or less than half covered by the leaf.

Compare each pupil's guess with the results obtained in their particular group.

How to show that plants respire. Page 71.



Class discussion and a teacher demonstration.

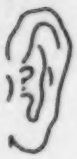
By asking questions such as "How can you tell if carbon dioxide is given off?" "Under what conditions would you need to do this experiment?", the pupils should be able to think up an experiment method quite quickly. Try not to tell them! (This experiment could be done by taking a leaf and putting it in a sealed bottle containing some purple bicarbonate indicator. If, after being in the dark a few hours, the indicator turned yellow, this would show that carbon dioxide is given off. This is similar to experiment 12, which shows that a plant does not take in carbon dioxide in the dark.)

You should try out this idea as a demonstration.
Have ready:

2 small plastic bottles, each containing 2 ml purple bicarbonate indicator, and caps

Some small leaves

Say to the pupils:



"We think that a plant gives off carbon dioxide when it respires. In the dark it cannot take in carbon dioxide to photosynthesise. Therefore purple bicarbonate indicator should be turned yellow by a plant in darkness. Shall we try this out?
Here I have two bottles containing purple bicarbonate indicator. Shall I put leaves in both? (The idea to get over here is that one bottle should be empty - as a control).

Put a leaf in one bottle, cap them both, andput them in a dark cupboard until the next lesson.

Then take them out of the cupboard and pass them around. The indicator should be yellow in the bottle with the leaf.

Ask the class what conclusion they draw from this.

The conclusion should be:
"The hypothesis is proved - green plants give off carbon dioxide when they respire."

Activity 7: Page 71

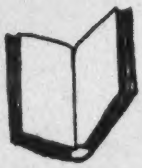
Give out bioviewers and biosets ZS/5.

The idea here is for the pupils to realise that air passes through a great surface area provided by many cells. In the leaf the exchange is slower and by diffusion only. In the lung air is forced in and out, and blood also travels in the capillaries, so the process is faster.

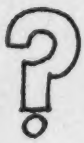
Answers to questions 3 & 5 on the bioset.

3: Air passes into the leaf through stomata. Inside the leaf oxygen and carbon dioxide gases are exchanged by diffusion in and out of the cells. Air can pass out of the leaf through the stomata by diffusion.

5 A piece of lung tissue has lots of open spaces with thin walls and these are air sacs. There are larger spaces with thicker walls which are capillaries. There are many capillaries for bringing blood close to the air sacs to collect oxygen and get rid of carbon dioxide. Air is forced in and out of the lung by breathing.



Pupils should now revise this section, and answer "How much do you know?"



ANSWERS TO 'HOW MUCH DO YOU KNOW? PART II'

1. carbohydrates; green plants; water/carbon dioxide; carbon dioxide/water; light.

2. carbon dioxide; bicarbonate.

3. oxygen; respire.

4. carbon dioxide; carbohydrates.

5. traps/catches; chlorophyll.

6. soil/ground/earth; roots.

7. surface area; exchange.

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